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(54) **PISTON AND SEAL FOR A STORAGE TANK**

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(52) **U.S. Cl.** **277/637**; 222/648
(58) **Field of Search** 277/644, 647, 277/648, 637, 640; 222/386

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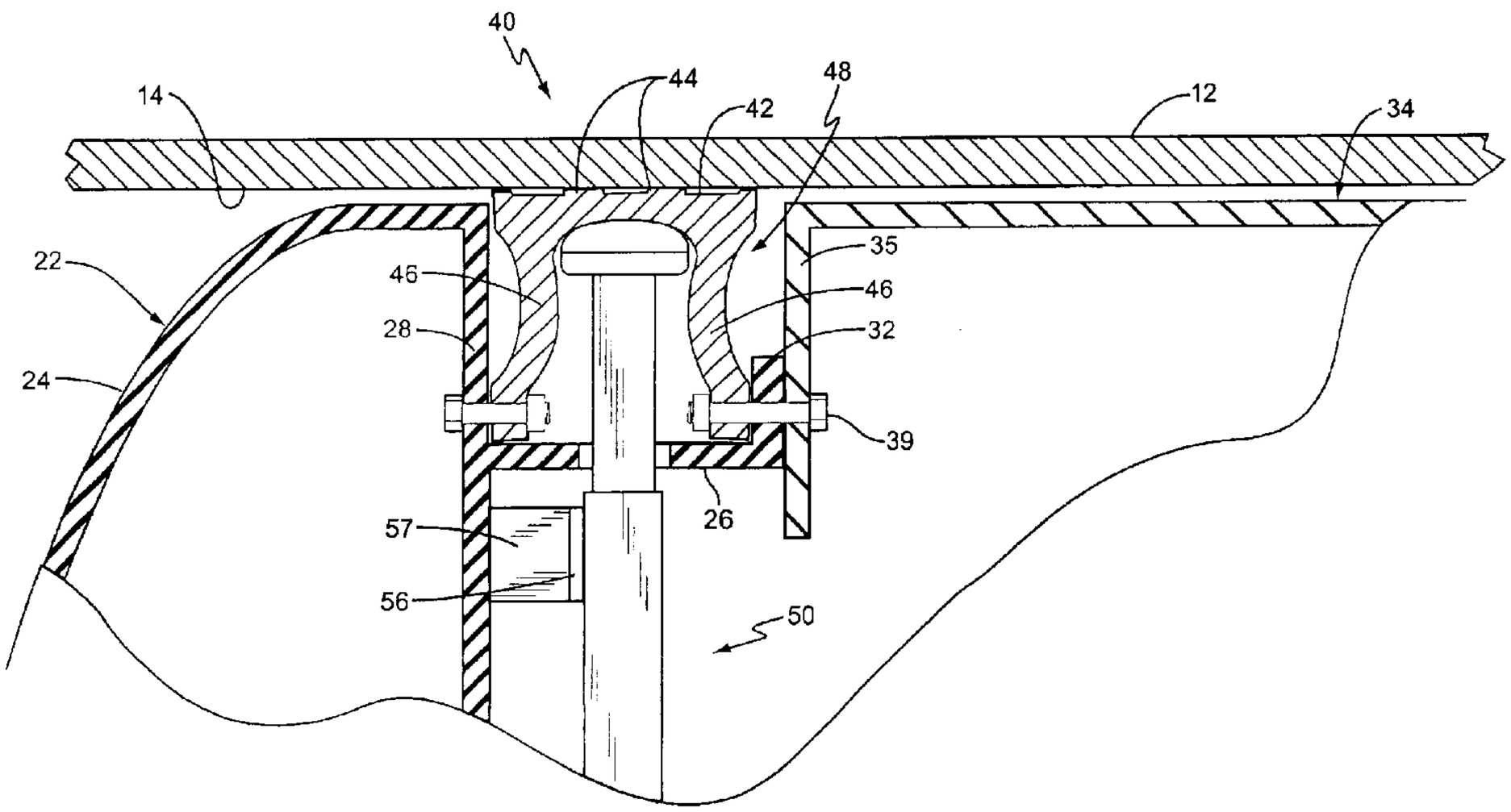
(57) **ABSTRACT**

A tank for storing fluid materials includes a piston having a channel, and an annular seal secured to the channel. The annular seal projects outwardly from the circumference of the piston. The piston further includes a plurality of radially arranged, spaced-apart tensioners that stretch the seal into sliding engagement with the interior surface of the tank. As the piston slides through the tank, the tensioners independently move radially inward and outward to compensate for shape-wise imperfections of the tank, such that the fluid materials extrude through the opening of the tank without bypassing the annular seal.

33 Claims, 6 Drawing Sheets



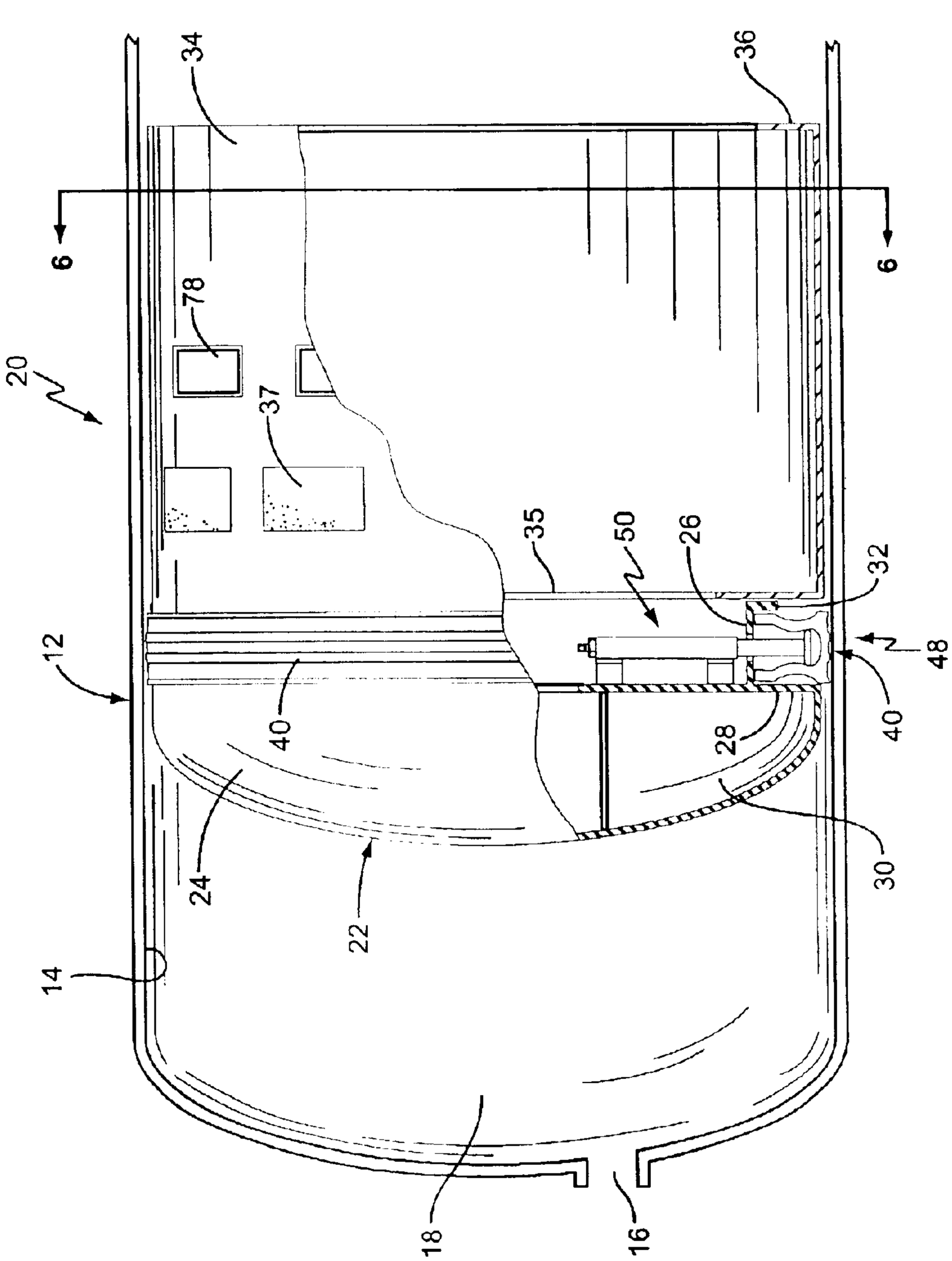


FIG. 1

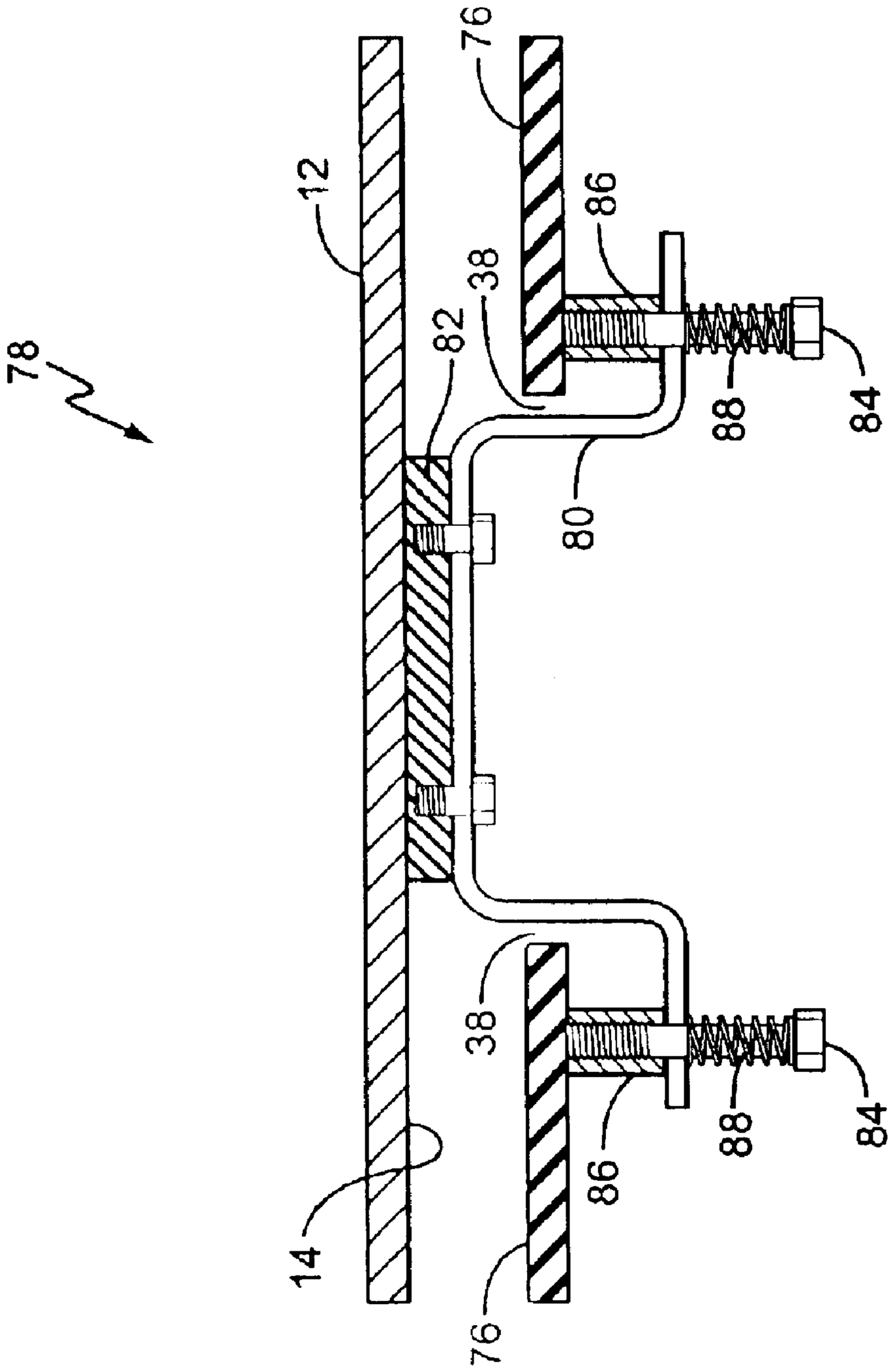


FIG. 2

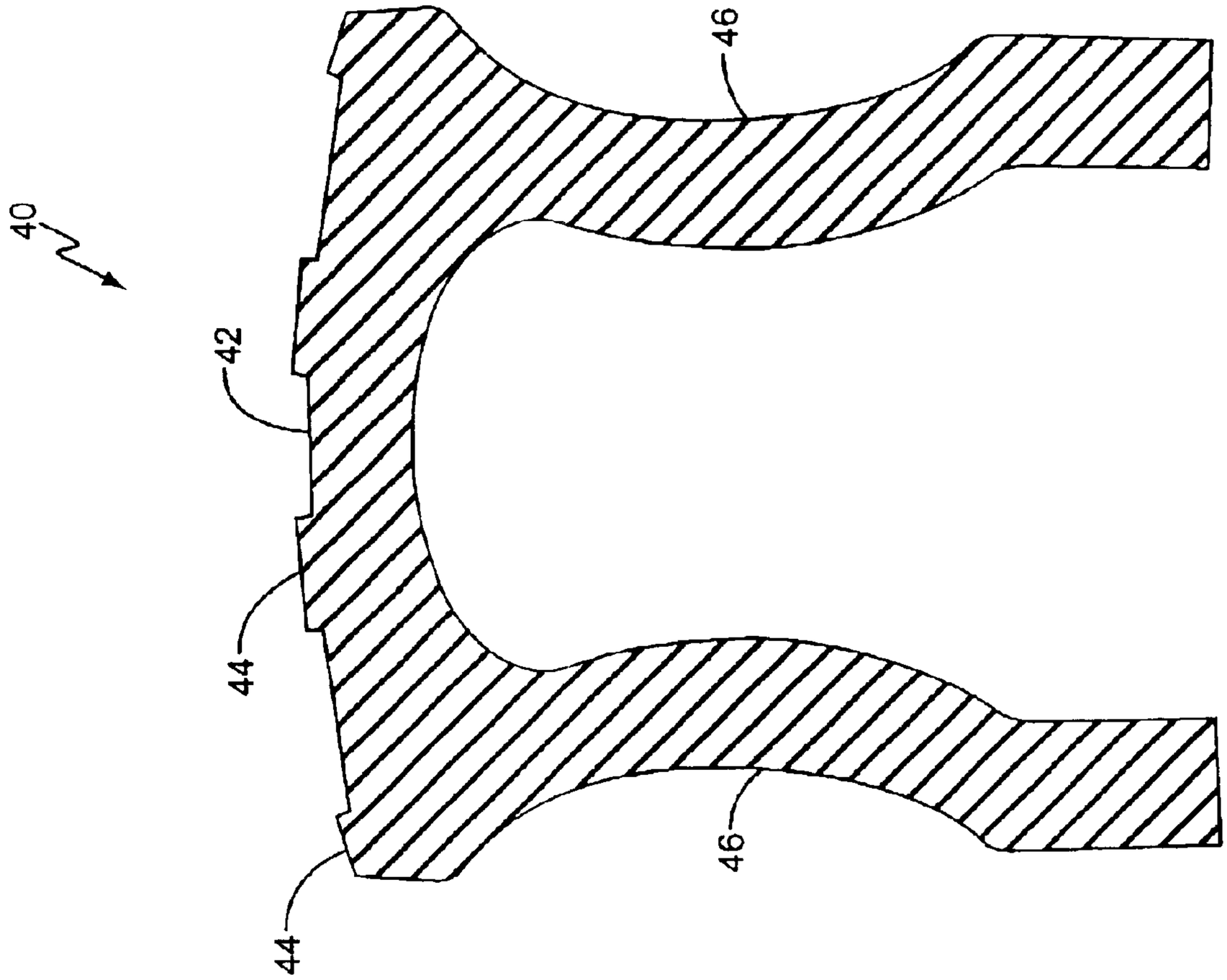


FIG. 3

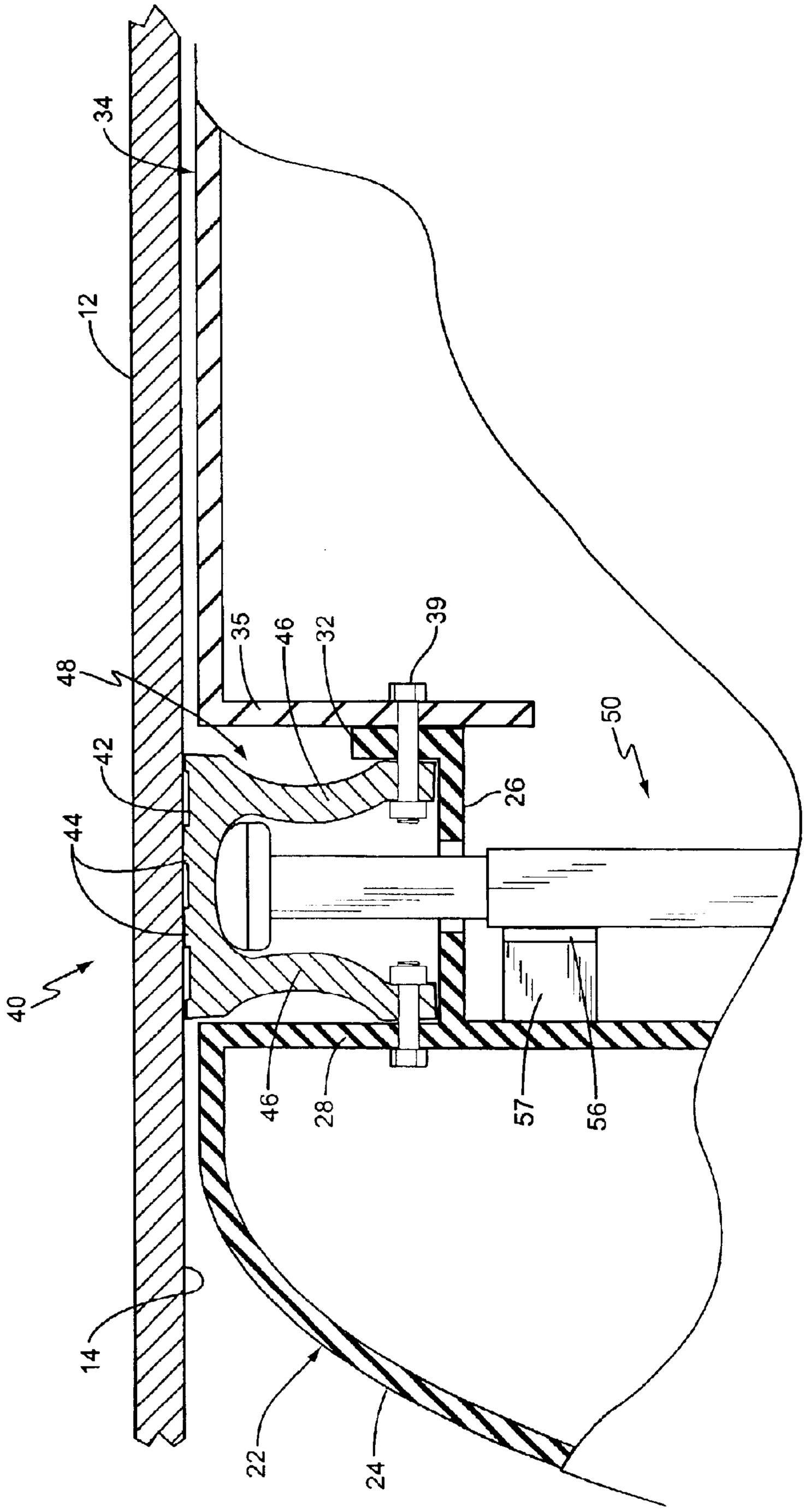


FIG. 4

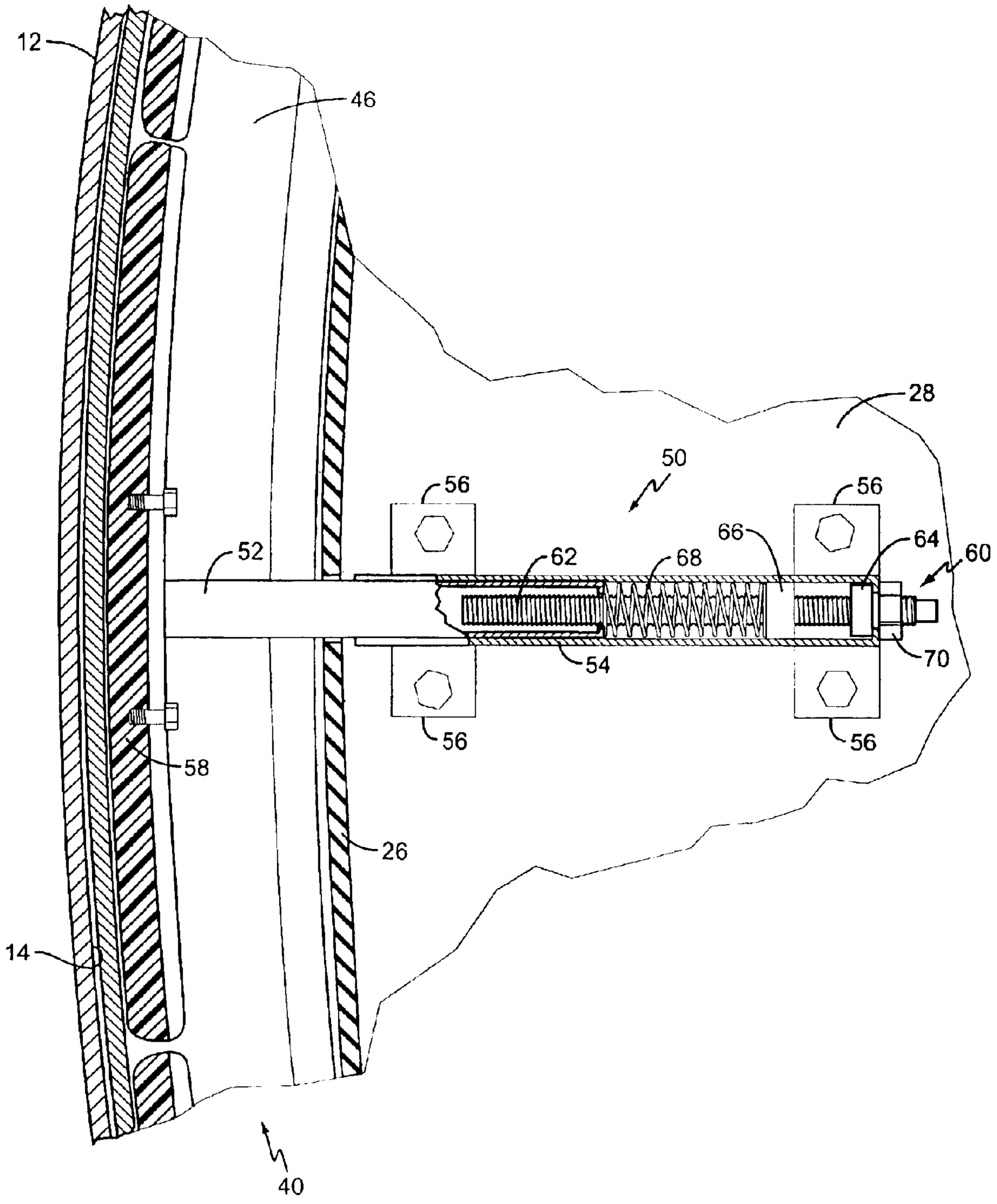


FIG. 5

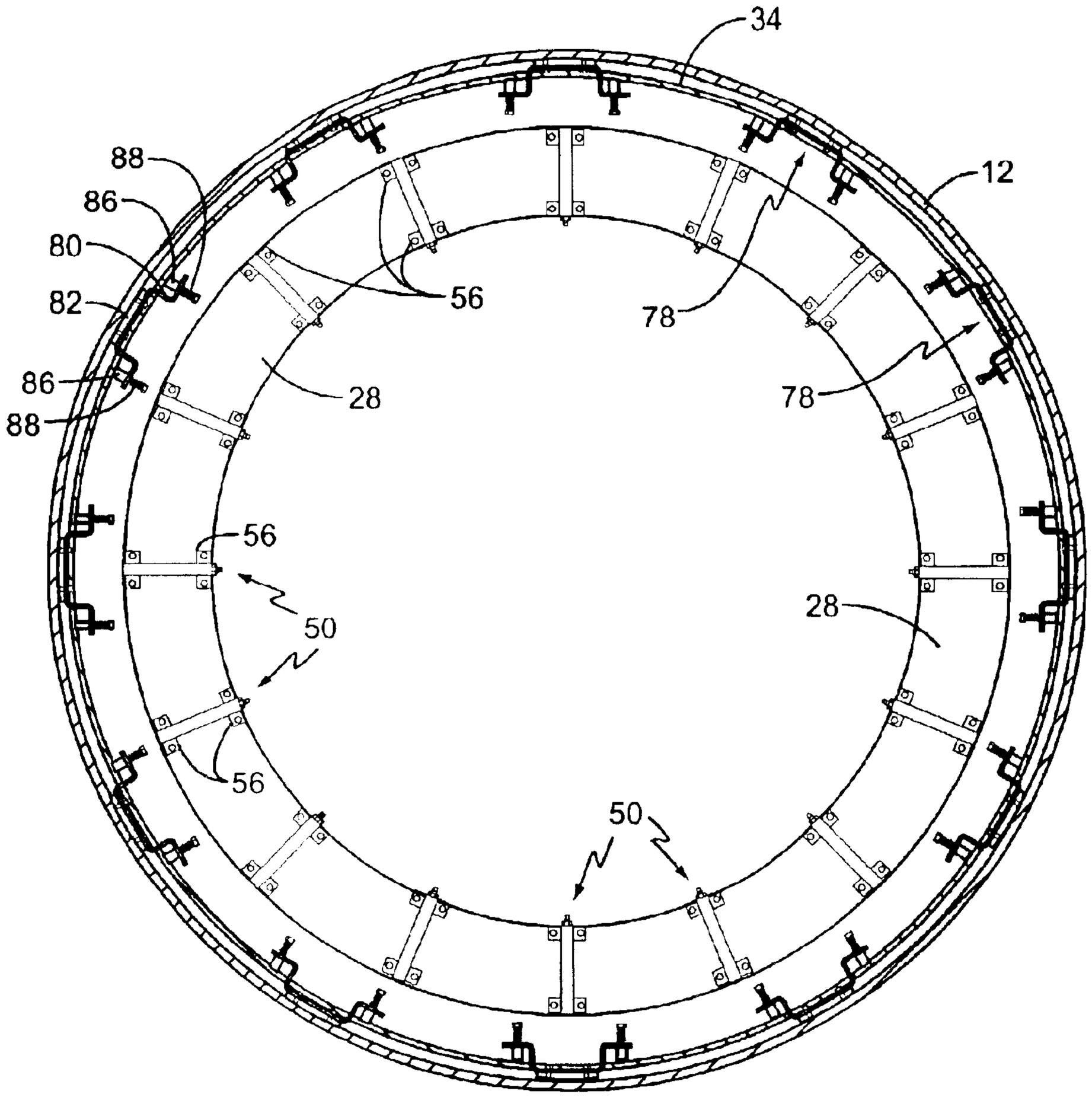


FIG. 6

PISTON AND SEAL FOR A STORAGE TANK

BACKGROUND OF THE INVENTION

The present invention relates generally to storage tanks for storing fluid materials, and in particular, to an improved piston for use in extruding the fluid stored therein.

Storage tanks, particularly those used in the transportation of viscous, fluid materials, typically comprise a piston that moves along a longitudinal axis in the tank to push the materials through and out an opening in one end of the tank. The piston typically includes a seal that "wipes" the interior surface of the tank, and prevents the backflow of material as the piston moves along the longitudinal axis. Problems may arise, however, when the tank is not perfectly round or has imperfections in the surface. For example, gaps may form between the seal and the interior surface of the tank allowing material to squeeze past the piston. Therefore, a mechanism is needed that will maintain a firm contact between the seal and the inner surface of the tank without creating unnecessary friction, thereby preventing the backflow of material past the piston.

SUMMARY OF THE INVENTION

A storage tank used to transport fluid materials includes a piston slidably mounted in the tank, an annular seal extending around the circumference of the piston, and a plurality of radially movable tensioners that maintain the seal in sliding engagement with the inner surface of the tank. Each tensioner includes an adjustment mechanism to adjust the amount of force applied by the tensioner. In one embodiment, approximately 16 tensioners are spaced around the piston. The tensioners can be independently adjusted to compensate for variations in the tank. The tensioners hold the seal in contact with the inner surface of the tank as the piston moves along the tank.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side view of one embodiment of the present invention showing the piston disposed inside a storage tank.

FIG. **2** is a cross-sectional view of an anti-canting member according to one embodiment of the present invention.

FIG. **3** is a cross-sectional view of the seal according to one embodiment of the present invention.

FIG. **4** is a cross-sectional view of one embodiment of the present invention illustrating the seal mounted to the piston.

FIG. **5** is a cross-sectional view of an exemplary tensioner according to one embodiment of the present invention.

FIG. **6** is a perspective view of an exemplary piston mounted inside of the storage tank.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to FIG. **1**, one embodiment of a storage tank according to the present invention is shown therein, and indicated generally by the number **10**. Storage tank **10** comprises a tank **12** having an inner surface **14**, and a piston **20** disposed within the tank **12** for expelling a fluid material **18** through and out an opening **16**, an annular seal **40** extending around the piston **20**, and a plurality of radially moveable tensioners **50** to maintain the seal **40** in contact with the inner surface of the tank **12**.

Tank **12** is normally cylindrical, and is preferably constructed from a non-corrosive material, such as stainless steel. Further, tank **12** may be mounted to a vehicle for transporting fluid materials **18** or may be stationary. A tank for mounting on a semi-trailer may, for example, be approximately 63 inches in diameter and approximately 40 feet in length. The tank **12** may be used to transport and/or store many types of fluid material **18**, including food products such as peanut butter and processed meats.

Piston **20** is disposed within the tank **12** and moves along the longitudinal axis of the tank **12**. The piston **20** is slightly smaller in diameter than the tank **12** and is mounted for sliding movement within the tank **12**. The piston **24** includes a head **22** and a body **34**, which may be constructed as separate pieces and coupled by any suitable means, such as by mechanical fasters.

The head **22** includes an dome-shaped front section **24** that contacts the fluid material **18** within the tank **12**, and cylindrical mounting collar **26**. A ring-shaped mounting plate **28** is welded or otherwise secured to the interior of the front section **24** and is supported by gusset plates **30**. The mounting collar **26** may be welded to the mounting plate **28**, and extends rearwardly to terminate in a flange **32**.

The body **34** comprises a cylindrical member having a front flange **35**, and a rear flange **36** to provide rigidity. The front flange **35** of the body **34** couples to the flange **32** on the head **22** of the piston **20**. Bolts **39** (see FIG. **4**) secure the two sections of the piston **20** together. When the head **22** and body **34** are secured together, a circumferential channel **48** is formed. The collar **26** forms the bottom of the channel **48**, the mounting plate **28** forms one sidewall of the channel **48**, and the front flange **35** on the body **34** forms the other sidewall of the channel **48**. This channel **48** extends around the piston **20** and contains the seal **40** as described below.

The body **34** further includes plurality of circumferentially spaced access openings **37**. The access openings **37** allow installers and maintenance personnel to inspect or examine the seal **40** from the inside of the piston **20** when the piston **20** is installed in the tank **12**. Installers and maintenance workers can use the access openings **37**, for example, to check for gaps between the seal **40** and the inner surface of the tank **12** after the piston **20** is installed in the tank **12**. The installers may then adjust the tensioners **50** as needed to ensure that the seal **40** fits snugly against the inner surface of the tank **12**.

The body **34** includes a second series of circumferentially spaced openings **38** for anti-canting members **78**, which are shown in FIG. **2**. Anti-canting members **78** ensure that the piston **20** does not skew or tilt from side to side when the piston **20** moves along the longitudinal axis of tank **12**. In the disclosed embodiment, 12 anti-canting members are evenly spaced around the circumference of the piston **20**. The number of anti-canting members **78** is not material to the present invention and those skilled in the art will readily appreciate that a different number of anti-canting members **78** could be used.

Anti-canting members **78** each comprise a spring-mounted bracket **80** and an anti-canting pad **82** attached to the bracket **80**. The bracket is made from a non-corrosive material, such as stainless steel. The anti-canting pad **82** is preferably made from a non-stick material, such as Ultra-High Molecular Weight plastic (UHMW), and is secured to the anti-canting bracket **80** by mechanical fasteners, such as screws. The anti-canting bracket **80** moves radially inward and outward on a pair of threaded guide rods **84** that are secured to the interior of the piston body **34**. More particularly, a pair of internally threaded spacers **86** are welded or otherwise secured to the interior of the piston

body **34** on opposing sides of the opening **38**. The spacers **86** provide a fixed minimum separation distance between the anti-canting bracket **80** and the interior of body **34**. The guide rods **84** thread into the spacers **86**. A spring **88** disposed on each guide rod **84** biases the anti-canting bracket **80** outwardly towards the inner surface **14** of tank **12**. As the piston **20** moves along the longitudinal axis of tank **12** towards the opening **16**, the anti-canting pad **82** slidably engages the inner surface **14** of tank **12** to prevent the piston **20** from tilting or skewing in the tank **12** as the piston moves along the tank **12**.

FIG. **3** is a cross-section of the seal **40**. Seal **40** comprises an arcuate crown **42** having a plurality of ridges **44** disposed thereon, a pair of opposing legs **46**, and an interior surface. Seal **40** may be manufactured using any material known in the art, but is preferably cast as a unitary construction from a generally pliable non-toxic material, such as rubber or a related rubber compound. Further, seal **40** forms a continuous ring that is approximately equal in diameter to the inside diameter of the tank **12**.

In this embodiment, ribs or ridges **44** are arranged to include a pair of outer ridges, or peripheral ridges, and a pair of interior ridges. The ridges **44** contact and slidingly engage the interior surface **14** of tank **12** as the piston moves towards the opening **16**, and substantially wipes the inner surface **14** clean of fluid material **18**. Thus, ridges **44** offer an improvement over existing seals by presenting less surface area to the interior surface **14**. This results in less friction and less wear and tear to the crown **42**, while simultaneously preventing the backflow of fluid material **18** beyond the piston member **20**. Those skilled in the art will readily appreciate that the number and arrangement of the ridges **44** is not material to the invention, and in fact, both the number and arrangement of the ridges **44** may be varied in any pattern along the crown **42** of seal **40**. The legs **46** of the seal **40** have concave outer surfaces that allows the seal **40** to stretch radially outward when biased by tensioner **50**. When the biasing force is removed, the legs **46** return to a normal unstretched state due to the natural resiliency of the material. The material is preferably chosen so that the seal **40** may withstand prolonged stretching and still return to an unstretched state.

As previously stated, the seal **40** mounts in the channel **48** created when the head **22** and body **34** of piston **20** are coupled. As shown in FIG. **4**, the legs **46** of the seal **40** are bolted to opposing sidewalls of the channel **48** by bolts **39**. The bolts **39**, as shown in FIG. **4**, may be the same bolts used to secure the head **22** and body **34** of the piston together. However, those skilled in the art will realize that various means may be employed to secure both the seal **40** within the channel.

As the piston moves toward the opening **16**, the seal **40** must compensate for variations in the tank **12**. The present invention achieves this goal by providing a plurality of tensioners **50** to hold the seal **40** against the inner surface **14** of the tank **12**. The tensioners **50** exert an outward force on the seal **40** to hold the seal in contact with the inner surface of the tank **12** as the piston moves along the tank **12**. The tensioners **50** are responsive to the variations in the inner surface **14** of the tank **12**, and maintain the seal **40** in sliding engagement with the inner surface **14** of tank **12** by moving radially inward and outward.

FIG. **5** illustrates one tensioner **50** in more detail. Tensioner **50** comprises a shaft **52** having a tensioner pad **58** mounted at one end, and a sleeve **54** to receive the other end of shaft **52**. Mounting brackets **56** are secured to the sleeve to facilitate mounting tensioner **50** to the head **22** of piston **20**. Those skilled in the art will readily appreciate the numerous ways in which to secure tensioner **50** to the head **22**. However, in this embodiment, mechanical fasteners secure tensioner **50** to a spacer block **57** that is welded or otherwise secured to mounting plate **28** of head **22**. Spacer block **57** is tapped to include one or more threaded holes that receive the mechanical fasteners, and substantially align tensioner **50** with the interior surface of the seal **40** in channel **48**.

A biasing member **68**, which in this embodiment is a compression spring, biases the shaft **52** radially outward through an opening in the collar **26**, and into engagement with the interior surface of seal **40**. As the tensioner **50** engages the seal **40**, the biasing force imparted by the biasing member **68** stretches the seal **40**. Tensioner **50** includes an adjusting mechanism **60** that allows adjustment of the force imparted by biasing member **68**. The adjustment mechanism **60** comprises a threaded bolt **62** housed in sleeve **54**. The biasing member **68** is disposed around threaded bolt **62**, and rests on a base **66**. A stopper **64** prevents the threaded bolt **62** from falling out of the sleeve **54**, while an exterior nut **70** prevents any unwanted rotations of threaded bolt **62** during use. To adjust the amount of biasing force, a user loosens the exterior nut **70**, and turns the threaded bolt **62** to the right or left, depending on whether or not more or less biasing force is required. Upon reaching the correct amount of biasing force, the user simply re-tightens the exterior nut **70**. This process may be repeated for each of the plurality of tensioners **50**, thereby allowing a user to independently adjust the amount of force imparted by each tensioner **50** to the seal **40**.

FIG. **6** illustrates one embodiment of the piston **20** installed in the tank **12**. In this embodiment, the tensioners **50** are secured to the mounting plate **28** and are spaced apart at equal intervals. Although the number and arrangement of the tensioners **50** may vary, the tensioners **50** are disposed such that, as the piston **20** moves towards the opening **16**, the shaft **52** of each of the tensioners **50** will move radially inward and outward independently of one another responsive to any variations in tank **12**. Further, it can be seen that the anti-canting pads **82** mounted to the anti-canting brackets **80** will also move radially inward and outward as required to maintain the piston **20** on a substantially straight path through the tank **12**.

Those skilled in the art will realize that many variations may be undertaken without departing from the scope of the invention. For example, although the tank **12** is described herein as cylindrical, it need not be. Other shapes, such as elliptical or oval, may be employed. Thus, the size and shape of the piston **20** may also be modified accordingly.

Further, the present invention is designed to work with any type of fluid material **18**. Peanut butter is but one example, however, other viscous fluids, such as grease, oil, ketchup, and the like, may also be stored within the tank **12**. Additionally, throughout the description mechanical fasteners are used to secure and mount various parts of the invention. However, it should be understood that the present invention contemplates the use of other fasteners, such as adhesives, and is not limited to the use of mechanical fasteners.

Likewise, the present invention uses a compression spring as a biasing member **68** to provide the biasing force to the seal **40**. However, other materials and methods, such as a pressurized fluid or gas, may be used to impart the radial biasing force on the shaft **52** of tensioner **50**, which in turn, exerts the force upon the seal **40** as previously described.

The present invention may of course, be carried out in other specific ways than those herein set forth without departing from the essential characteristics of the invention. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive and all changes coming within the meaning and equivalency range of the appended claims are intended to be embraced therein.

What is claimed is:

1. A storage tank for storing fluid materials comprising:

a tank having an inner surface and an outlet;

a piston slidably mounted in said tank for expelling material through said outlet;

an annular seal extending around said piston; and

a plurality radially movable tensioners for applying a radial force to said seal to maintain said seal in sliding engagement with said inner surface of said tank.

2. The storage tank of claim **1** wherein each said tensioner comprises an axially movable shaft and a tension pad mounted at one end of said shaft.

3. The storage tank of claim **2** wherein each said tensioner further comprises a sleeve to receive said shaft and a biasing member to bias said shaft radially outward to maintain said sliding engagement.

4. The storage tank of claim **3** wherein said biasing member comprises a compression spring.

5. The storage tank of claim **3** wherein said biasing member compresses in response to said shaft moving radially inward.

6. The storage tank of claim **3** wherein each said tensioner further comprises an adjustment mechanism to adjust the amount of biasing force applied to said shaft.

7. The storage tank of claim **1** wherein said seal comprises a crown having a plurality of ridges disposed thereon.

8. The storage tank of claim **7** wherein said seal further comprises a pair of opposing legs having a concave surface.

9. The storage tank of claim **8** wherein said seal is mounted to said piston.

10. The storage tank of claim **1** further comprising a series of access openings disposed circumferentially around said piston member providing access to said seal.

11. The storage tank of claim **1** further comprising a plurality of anti-canting members disposed circumferentially around said piston.

12. A piston comprising:

a head having a proximal surface and a distal neck;

a body mounted to said head;

an annular seal secured to said head, and projecting outward from the circumference of said piston; and

a plurality of radially movable tensioners for applying an outward force to the inner surface of said seal.

13. The piston of claim **12** wherein each said tensioner comprises an axially movable shaft and a tension pad mounted at one end of said shaft that engages the inner surface of said seal.

14. The piston of claim **13** wherein each said tensioner further comprises a sleeve to receive said shaft and a biasing member to bias said shaft radially outward.

15. The piston of claim **14** wherein said shaft extends radially through a sidewall of said neck, and stretches said seal radially outward.

16. The piston of claim **14** wherein said biasing member comprises a compression spring.

17. The piston of claim **14** wherein said biasing member compresses in response to said shaft moving radially inward.

18. The piston of claim **14** wherein each said tensioner further comprises an adjustment mechanism to adjust the amount of biasing force applied to said shaft.

19. The piston of claim **12** wherein said seal comprises arcuate crown and a pair of opposing legs having a concave surface, and wherein a selected one of said legs is mounted to a sidewall of said neck.

20. The piston of claim **19** wherein the other leg of said opposing legs is mounted to a flange of said neck.

21. The piston of claim **17** further comprising a plurality of anti-canting members disposed circumferentially around said piston.

22. The piston of claim **21** wherein each anti-canting member is axially movable and comprises an anti-canting pad.

23. The piston of claim **21** wherein each anti-canting member is mounted to said piston by a pair of guiding rods having one end secured to the interior of said piston.

24. The piston of claim **23** further comprising a spring on each said guiding rod to bias said anti-canting member radially outward from said body.

25. A seal for a piston comprising:

an arcuate crown;

a plurality of ridges disposed along the surface of said crown for contacting an exterior surface; and

a pair of opposing legs extending from the outer periphery of selected sides of said crown.

26. The seal of claim **25** wherein said plurality of ridges comprises at least one interior ridge.

27. The seal of claim **26** wherein said plurality of ridges further comprises at least one peripheral ridge.

28. The seal of claim **25** wherein said seal is constructed from a generally pliable material.

29. The seal of claim **25** wherein each said leg has a concave surface.

30. A method of expelling a fluid material from within a tank having a piston disposed therein, the method comprising:

stretching an annular seal into sliding engagement with an interior surface of said tank;

sliding said piston member toward an opening in said tank to expel said fluid material through and out the opening; and

independently biasing a plurality of tensioners radially outward as said piston member slides towards the opening to maintain said sliding engagement.

31. The method of claim **30** wherein stretching said annular seal member includes biasing an inner surface of said seal radially outward with a plurality of tensioners.

32. The method of claim **30** further comprising independently adjusting said plurality of tensioners to adjust the amount of biasing force applied to said seal.

33. The method of claim **30** further comprising compressing a compression spring within said tensioners responsive to the inward movement of said tensioner as said piston slides towards the opening.

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